## Predicting the Evolution of Ecolo Diked Wetlands in the Sacrame

G. Simensted, J. Cordei, and J. Toft, Welland Ecosystem Team, Spho Philip Williams and Associates: D. Reed, University of New Orleans <u>and C.</u>

### Abstract

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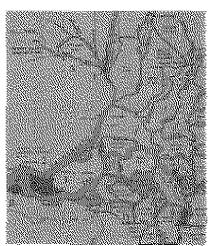
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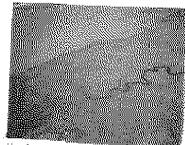


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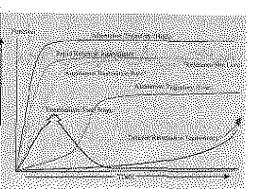
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### Methods.

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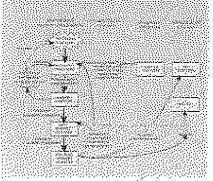
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### References

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Prepared by: Wichelle Orr, Philip Williams and Denise Reed

Philip Williams & Associates, 770 Tamalpals Drive, Spins 401, Corte Madora, CA 94925.

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natural freshwater tidal wetland and have now reverted to tidal areas that were leveed in the past Sacramento-San Joaquin Delta. breached-levee sites in the geomorphic evolution within model of freshwater tidal wetland processes on deeply subsided, subestablishment through natural ground at intertidal elevations vegetation quickly colonizes bare indicates that freshwater tidal marsh breached-levee sites in the Delta were leveed. Our examination of up to 20 feet during the time they action. Some of these sites subsided Breached-levee sites are former This study presents a conceptual (within several years). Vegetation

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associated with this type of of the Delta by breaching levees elevation faster than the rate of sea restoration is re-building bed areas, one of the major constraints subsided, up to 20 feet in some Since most of the potential and re-introducing tidal action. ecological functions of large areas growing interest in restoring the Delta have now been leveed. In the in the Sacramento-San Joaquin past few years, there has been a Over 95% of the 320,000 acres of restoration sites are significantly historical freshwater tidal wetlands

fauna studies. The information presented here is part of an origoing study and will be refined as the study continues.

# 

We examined the geomorphic evolution of six breached-levee sites and four natural reference sites in the Delta (Figure 1). Breached-levee sites are previously-leveed areas that have been re-flooded, either intentionally or accidentally. Reference sites are remnant portions of welland that have never been leveed. We characterized the following hydrologic and geomorphic features at some or all of the sites:

se colonization, expansion, and crosion of marsh vegetation over

fidal areas takes significantly

restoration efforts,

applied in planning future Delta

level rise. The conceptual model of tidal wetland geomorphic evolution

elevations, such as beneficial re-use of dredged materials, accelerates vegetation establishment and may be the only way to ensure restoration of vegetated marsh in deeply subsided sites.

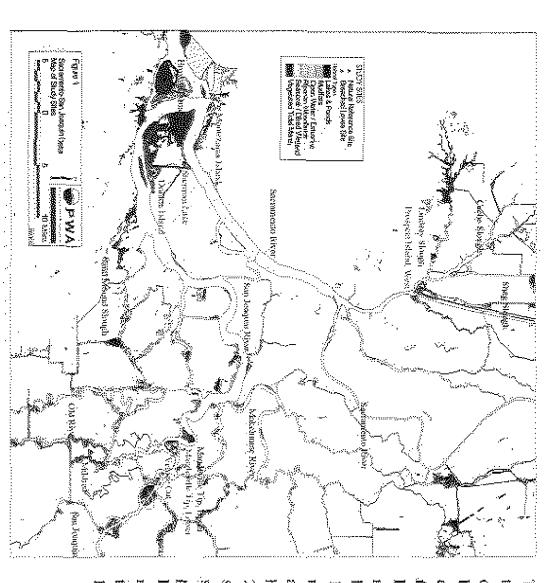
all. Artificial means of raising bed

larger study of breached-levee

Delta wedlands with the University of Washington, California Department of Water Resources, and University of New Orleans that includes sedimentation, fish, invertebrates, and other flora and

type and elevation of wetland vegetation

- tidal characteristics
- marsh plain elevation



the Delta, is shown in approximately mean over the last 5,000 years Figure 3. remaining natural marsh in Browns Island, the largest peat accumulation. sedimentation and organic sea level rise through and keeps pace with response to a rising sea Delta perimeter in floodplain around the expanding into lowland tidal marshplain exolved higher high water (Figure marshplain tends to be at 1979). The natural level (Atwater et at., by transgression ---The original extensive

sedimentation until vegetation can establish. The conceptual model (Figure 2) predicts the following Vegetation colonization of extensive subsided areas requires the build up of bed elevations through

- Once a leveed site is breached, marsh vegetation ("tule") establishes rapidly at intertidal elevations (Figure 4).
- of 5 to 10 feet linear feet/year) and requires sheftered, low wave energy conditions. Once established, vegetation spreads to lower elevation areas (approximately two feet below mean lower low water) by lateral colonization from the initial patches. Lateral colonization proceeds at a slow pace (maximum
- level rise). The presence of vegetation promotes subsequent accumulation of both organic and inorganic sediment though at a relatively slow rate (approximately 0.02 to 0.04 feet/year [6 to 12 mm/year] above the rate of sea
- (Figure 5), The rate of subtidal accumulation in open water areas is slow and may be less than the rate of sea level rise
- W vegetation at intertidal elevations (Figure 6). The use of fill, such as dredged material, to raise site elevations results in rapid establishment of marsh
- Where wave energy is sufficiently high (due to long fetch lengths, boat wakes, etc.), crosion and loss of marsh

figure 2 Conceptual Model of Freshwater Tidal Wetland Evolution SHWONE (Bugo 藍 (bottom elevation above ML1 M) forth subsidence tessett ein mot August pioseer colonization colonization lateral expansion promeer. colonization > 雅芸芸術 net accumulation >

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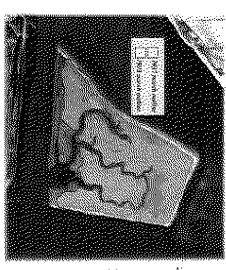
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# figure 3 Browns Island

Browns Island is the largest remaining natural tidal marsh in the Delta and the only site with an extensive branching channel network typical of the historical Delta. Although Browns Island is slightly brackish, it provides one of the best analogues of the Delta's historically vast areas of freshwater tidal marshes.



# figure 4 Lower Mandeville Tip

Lower Mandeville Tip provides an example of rapid re-vegetation at a shallowly-subsided site following breaching. The majority of the site was at intertidal clevations when it breached in 1933. This aerial photograph, taken in 1937, shows nearly complete re-vegetation four years later. The photograph also shows significant erosion between 1937 and 1993 in the southern part of the site, where wave energy is high along the Stockton Deep Water Ship Channel.

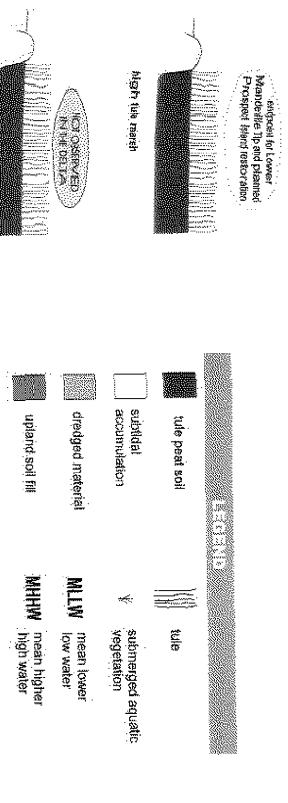


# figure 5 Mildred Island.

Mikited Island was a deeply-subsided site (approximately 16 feet below mean higher high water) when it breached in 1983. This 1993 infra-red photograph shows that funited perimeter vegetation (shown in red) established in the 10 years following breaching and that most of the site remains open water (shown in black).

The conceptual model has the following implications for future Delta wetland restoration:

- Shallowly-subsided sites. Restoring tidal action to shallowly-subsided (intertidal) sites is expected to result in natural marshpiain elevations at mean higher high water. network of drainage channels will also re-establish. Up to 100 to 200 years may be required to re-establish rapid re-establishment of a vegetated marshplain. Where the renmant channel system is intact, a natural
- Meeply-subsided sites and natural sedimentation. Natural sedimentation and organic accumulation cannot may be an effective way of speeding the rate of natural sedimentation, although this method is untested. fetch conditions typically encountered in the central Delta. Limiting wave action and wind-driven currents be relied upon to build marshplain elevations to intertidal elevations for the type of deeply-subsided, high wind
- ™ Deeply-subsided sites and beaeficial reuse of dredge material. Beneficial reuse of dredged material is a creation of the appropriate conditions for natural tidal action to scour channels. tidal channel habitat, however, requires special design consideration, such as grading during construction or promising technique for restoring vegetated marsh to deeply-subsided sites. Creation of ecologically-valuable



The conceptual model has the following implications for future Delta wetland restoration:

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\* Deeply-subsided sites and beneficial reuse of dredge material. Beneficial reuse of dredged material is a may be an effective way of speeding the rate of natural sedimentation, although this method is untested. terch conditions typically encountered in the central Deha. Limiting wave action and wind-driven currents be relied upon to build marshplain elevations to intertidal elevations for the type of deeply-subsided, high wind

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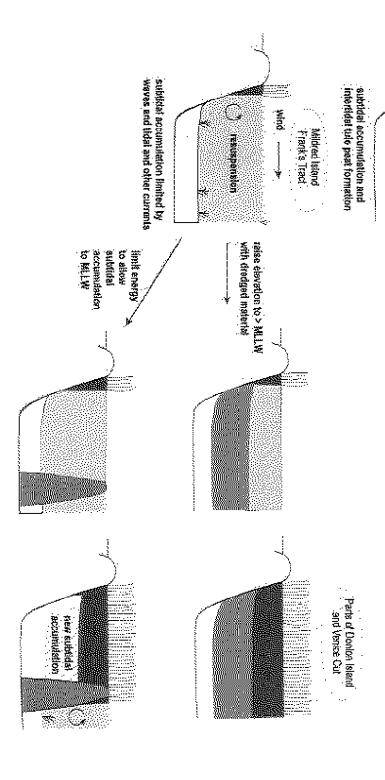
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# figure 6 Donlon Island.

Donlon Island is a breached-levee site that has been fully tidal since 1937. Nine dredged material islands were created at Donlon Island in 1985 as part of a beneficial re-use effort. Initial colonization of bare soil occurred rapidly for approximately the first two to three years, then slowed or stopped (USFWS and USACE 1990). This photograph was taken in 1997.

of the University of California at Davis for her vegetation expertise. ACKNOWLEDGMENTS: The research when which this poster is based was funded by Category III. We wish to thank Charles Simenstad at the University of Hashington for his assistance in developing the conceptual model and for providing graphics support for this poster and Michelle Stevens

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### Results—Central Delta

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### Keşuits—Mestern Delta

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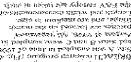
### THE FISH/INVERTEBRATE FOOD WEB IN THE SA THE EFFECT OF THE EXOTIC PLANT E

Jason Toff, Charles Simenstad, and Jeffery Cordell. Wetland Ec



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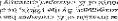
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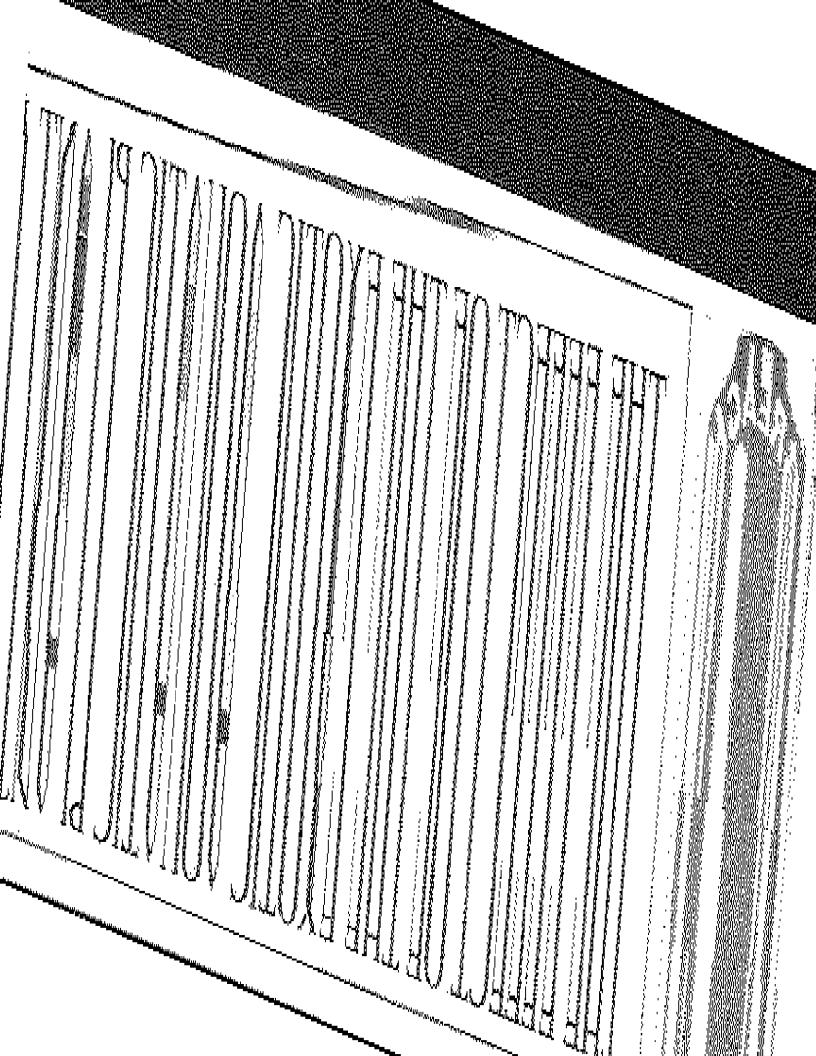
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# THE EFFECT OF THE EXOTIC AQUATIC PLANT E THE FISH/INVERTEBRATE FOOD WEB IN THE SA

### Jason Toft, Charles Simenstad, and Jeffery Cordell. Wetland Ec



FBG. § Eithlannin ergssiper. Water Hymones:

PKG-3 Catch of E. conveiges along the march temper

### ABSTRACT:

Einflarentia consistent (Welco Physicial) is a functing agontic macrophyte that was incredated into the Politics of Section (Welco Physicial) in the Politics (Continuous Institute to Bright, and has a tristray of workships in basis in teaming prominence, definition of Englit, and has a tristray of workships in takings, in the prominence of the prominent prominence, definition focus, a property of the same built as a function of the continuous habite plant (Set Continuous) between the same built at a function of the continuous tristration of the same built as a function where areas in the politic same of the same with chamber in the Politics of the contract the beaminest straying of 2.4-D. The relative of the functions with the macrophysic of the same than the sa

As part of the BREACE research entering (see BRUACE) position and in pinionality with confidence with a substruction of the electricity of the property of the

### INTRODUCTION:

The infrastine of if, changings has caused a bothed of controversy over issues of control and trainagement. By the 1989s, the chandraian became a trinditive to book trainfol. Chamical coarset of if. Crashipes carrontly has an arband coat of approximately \$1,000 for \$100 for Thailan, personal communication). Biologists invariant such as it. Crashiped band become widesproad on a global level. Exotic species can alter the population dynamics and continuity structure of native occayacous, and are primarily structure of native occayacous, and are primarily structure of native occayacous, and are primarily structure before the San fermions. This is especially important in the Sacreteonicyton Principle Delinius the San Francisco Bay area is considered the native output in the United States area arouthed by himself activity (Nichols et ill. 1986), say realy by the most invalual espacy to the world (Cohen and Carlion 1998).

Research disturbers in the mortal has shown that the most of E. crossipes can be reported babilet for applicable magazina crossisties, mainly simplicable (Cope) 1987. Proving ages in tegeration (FAV) can use be beneficial as a nearchy habited for journile lighter, as well as many proceeding the process of E. Provinges enough proceeding the process of the same can cause into dissorbed copyers, high destrins production, and surrescence of submorged yegonome (Cope) 1987). The charge of E. Crossipes on comments desarries as entire red in a same into discontinuous continuous of E. Crossipes on Comments desarries as entire as a submorged to its native functional continuous has not been smilled in the Deta, and listo examinal absorbers. This configuration approach for same labelia, as E. Crossipes is the Delta. It is expected that involved case receives and density will be different between the two vegetas on types, due to changes in: (1) spatial complexity of the vegetative structures (Figs. 1. 2. 3). (2) shading affects of deast energies. (3) shad detributed teastion (Cope) for his pass of vegetation produce. (5) shad detribute devaporation (Cope) for his pass of the Salvineoretrane productorary for the particularly acknown, and are of impletance of the field involved and pass of passing action of the pa

### OBJECTIVES:

(i) Characterize the assemblights of macrotromistrates in the score, because macrotropy stehrates, and terrestrial insects associated with E considers and  $\theta$ , such difficults.

(2) Characterize the resideral fish assemblyizes and fixed web postoways.



### METHODS:

Study Sizes We are knotying 3 sites in the Colin, which are a subset of the 10 study sites involved to the BREACH research program (Fig. 4). Site A was sumpted in June of 1998, and Sites B and Cheek sampled in August and 1998, All regardition further into breated on the march fringe, and are median in size. Leagurand whits important is size.

Leagurand whits impourement of the FAV cancery for taken at each patch.



MG-4 Magnis shely sheet

### <u>Biological</u>, sa<u>mpling</u>

(1) Ipstreasting traverselvorus tiving to the most measure? On violations and subspleed by manufacting plans strangers. Natural report of the most make the countries of the most report of the most make the countries of the most report of the most report of the most report of the most in with the most of the most o

(2) Benthic invertebrates are sampled with a 3-inch diameter core to a defined 10 cm. Sampling is and conducted at country arounds take (Neitput sp.) and apprecia purches when present.

(3) Leves fulfact (repears used to seeple the terresign) insects (iving in the regeluting catelytes. These trajs consist of a reconsignial day (35-cm x 58 cm) filled with source water. The teaps are ashesed in PVC grains at each side, allowing wideful increasing with the tides, The trays are collected after 24 firsts. Simplify is also consisted at sourcey energies the (Netrous Sp.) and reputting patelies when present.

(4) Subse-neuting is used to sample fish underneath PAV. Although not presented in this report, this Expansional of World Resolution (CRME) sixt is assuming this in shallow water areas administ to PAV using a source setting just it is a subsect to PAV using a source setting just a subsect to the product of the setting for the control of the setting that the product is a subsect of the control of the product of the control of the control of the setting that the PSI (Percent Strictlening Index), with a value of 101 showing complete stratup.

Physical Summing Meastresments of dissolved crypton and patch size are taken at early FAV patch.

### RESULTS AND DISCUSSION:

The legismi Samphak

(1) Enterothic Inversebrates in the Roots: The amplificate Company's forlidants, Printella attern, and the inequal Concidents because the translation is a statement in Fig. 5, see Box A for a description of simplifieds and sequely, many of which are introduced notion for described from the Polls: Research are specific for made the and sequely differences in investment translations into automatic and sequely differences in investment translations between E. translated and the pairwise H. attern at H. ambethier. (and richness and the Statemen-Weiter Diversity Index are higher for H. ambethier in Jane (Sine A), but segmes to the press, theorems B and C. Table 3). This correlates with the reak bloom of H, imbether in from and the peak bloom of G, consider in August.

(2) Benthic Inverse-mass: Office-hances represent the most identical tests oversit@p.6). In Jind (Site Al, two selmess and the Shancer-Weiner Directory Endes are growth higher for PAV then for envergent and special state (Table 1). However, he August (Site B), box richness in E. crassifies is equal with that for the envergent strent, white B institutes a city has high values. This is presentedly one to the high plant detriens deposition on a satisfact with E transform. Most of the additional tax in the FAV represent fall-out ampripment and languages from the coveriging from these community.

(19) Tigresteint Insects in the Vegengion Crimery: Chiestosinsons and Celletifosh segrenate for their Southern have leavest by inno (Fig. 7). The eigendance of Chemistidae in H. materilan patches is the region difference with Eleverylpon Messurements of take tichness and the Standage-Weitst Diversity Index see signing for FAV, sid and both higher than energy t and riparion state (Table 3).

(4) Fish: Ministers and everage temples for all fish captured to the same net samples ablancially the supplies of E. erassions at site C are as inflower is juvenile Bungiff (Legonile morrogistum). 15.85 time; (8 small) product Bungiff (Legonile morrogistum). 15.85 time; (8 small) product Bungiff (Legonile morrogistum). 15.85 time; (8 small) product Largement Bungiff (Legonile morrogistum). 15.85 time; (8 small) product S. 55.89 time; (8 ministers) products; (5 ministers) products; (5 ministers) products; (5 ministers) products; (6 ministers) products; (7 ministers) products; (8 ministers) products; (9 ministers) products;

Special Sampling At the Bidissolved obygine levels are injusticantly lower undernanth both FAV position than at emergent strate, with E. crossipin having a slightly lower value than H. modellate (Fig. 9). At size C. E. crossipin has a track blacker value. This could again he doe to the high plant details, despitation rate associated with E. crossiped. Anythic PAV public area associated with E. crossiped. Anythic PAV public area and side on the high plant details, despitation rate associated with E. crossiped. Anythic PAV public area and did not have a strictly defined possibly.



# THE EFFECT OF THE EXOTIC AQUATIC PLANT E. THE FISH/INVERTEBRATE FOOD WEB IN THE SAC

### Jason Toft, Charles Simenstad, and Jeffery Cordell. Wetland Ecc



PKC ( E)Mhartia c'assigles. Water Bysoleth

PROL 3 Pagets of Elegrassipers along the marsh france.

### ABSTRACT:

Eliminaria annaipes (Wajor Erjabriah) is a floating aquaric macrophyre that was introduced thin the Sacramendol'san Respect Data region to the 1940's 'E annaipes is unitive to Brazis, and has a justary to weakersale interests. In internal other provinces, the internal other provinces and associated materials interests. In the provinces is an important research Respect Administration of the comment of the Later provinces of the seaso habital as E materials in the Data is Hydrograph underlines (Panayavan). Both plants are abundant to shallow water brazes of the control Data, although the Department of Resisting and Waterways controls abundance of E creatings with chemical appropriage of 2.4-13. The relative effect on compacting symmetric of Examples as compared as its autoble pative constroper. If imbellian is technosed in a specied that invertebrate and richness and density will be different heliowen the two invegnation typics due to distant physical and biological chameters lies of the annables.

As part of the BREACES research phologous uses DREACES posters and in continuation with collinationality DWR research on fish sessentiages in challow water habitat, we shall investigating food with linkages between investebrials proy associated with E. crossiques and H. tembritate. Assistionally, we are incessoring expectation parch size and disactived copyed levels. Both plants have disactived experiences assemblinges in their root masses, decribed by see players. High the or analyses show that these amplipacity provide food for Ref. in the does We are also eligibearcherizing the tractive to the showers concept of the two points, and the left final formation of the compliants and the first first food for the decrease didden out H. Crossiques, as companied to observe the support of the two points.

### INTRODUCTION:

The invasion of E. transigns has exceed a suched of distribution is used it control and transignment. By the 1980s, he aluminated become a strategic to best traffic. Charactel control of E. transigns correctly has an annual cost of approximately \$1700/600 (Yan Thalken, presented communication). Biological invaders such as E. cransigns have become widespread on a global tevel. Existic precise can other the population dynamics and community sources of anise because in the Sectionary's sources for its standard the foliates. This is expectally impurious in the Sectionary's footier Delta as the Sectionary to the Erited States are profitted by formula activity (Newbord II, 1986), and may be the tonal invaded estuary in its winter (Coffice and Carline) 1988).

Research absorbers in the world has stoken that the world of E. Criscolses, can be imparted to Exhites for epibenskie mogroioversebrases, manty ampripada (Copps 1987). Floatiag aquabic roccolision (FAV) can also be beneficial as a nursery busiss for juvenile lishes, as well as . strany invertebrates. This is reten the pershell on patric size, as target patrices of Europeanical can ease low disserved accepts, high details production, and senescence of subscences vegetation (Cohel 1987). The effects of Elemissipes on community dynamics as compared so its native fenesional energy reas has not been studied in the Seira, and little examined disentacine. The ration Hallow could underliste (Pringuise) functionally complex the same babilaties. El conseigns in the Detra. It is expected that inventional etaxic exchange and density will be different between the two vegetation types, due to changes in: (1) spatial complexity of the regulative structures (Figs. 1, 2, 5), (3) strading effects of delian compries. (5) amount . aind localists of plant language. (4) densities of regulation patches, (5) plant distribus deposition rate, (6) geometrates, (7) dissolved expres levels, and (8) rates of evaporeánspiration (Copal 1987). Effects on the lishVinterlebrate poolalos-free feed tobact particularly unknown, and are of inequations due to the prominence of PAV as a station Justified water in this food wido.

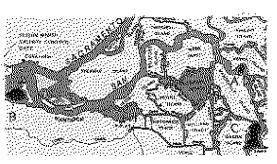
### OBJECTIVES:

(1) Characterize the assemblopes of international left use in the robbs, denotate macroimostrobrosos, and teriostrial insects associated with E. grannipes and H. 108bellaen (2) Characterize the resident lists assomblages and food web pathways.

(3) Characterina physical measurements of dissolved employ and patch share

### METHODS:

State Sites We are studying 3 sites in the Delta. Which are a subset of the Delta Which are a subset of the Delta CR residual program (Mg.A). Site A was compled in Jame of 1998, and Sites Radia C were complete in August of 1998. All vegetation patches are fee seed to the manual frage, and are medium in size. Length that which manual manual patches are the seed to the manual frage.



BBQ & Map of steely sites.

Biological Sampling .

(1) Hypercular investments living in the mild masser of the vegetation are mangled by statutally exited in page plant sparples. Materiapset brackes are then separated from the collected 2015 three by contesting the room mass party to executing a 10% ethanol. Concept surface after 50 determined by contesting the number of traver in each plant excepte to the number of traver in each plant excepte to the number of traver.

(2) Bendire inverlogistes are sampled with a 2-ineb simplest core to a depth of 16 cm. Sampling as also conducted it bearing impropert total Children sp.) and rigidism patches when present.

(3) Ensect Felical Imply are used to sumple the legressical insects living to the repetation databases. These traps empire of a cooleogular leafy (55-cm a 10-due) titled with every worm. For many are noteened in PVC, press at each site, allowing sequent movement with the trips are delicated after 24 times. Sampling is also constanted at nearby expressed take (Scriptus sp.) and dipution patches when pressed.

(4) Sering multing is used to sample fish indexpendy [AV. Attrough not presented in this report, this .
Department of Water Resources (DWR; also is superling fish in shallow water areas agreent to PAV using scine marring face poster by Geimaldo es at). Fish are saven for diet analysies. Prey items are ranked based on mostified IRI findex of Nothing Imperpaced values. Each coarley with inverselymnes is calculated using the - PSI (Percent Similarity Index), with a value of 100 showing complete overlap.

Physical Sampling Measurements of dissofred exygen and patch size are taken at each FAV patch.

### RESULTS AND DISCUSSION:

Sicogidal SargaSag

Or Epiperathic Inversibilities in the Recust The amplitifieds Crimenters (Idifidated). Writelia astern; and Gammara dathers, and the isopoid Caeridated meoniculi sinch the most abundant is an owned; (Fig. 5), see Dist. A for a discription of amphipods and isopods, using of which we introduced induce first records for the Delta's Results are specific for such site, and signify differences in inventebase communities powers. Excremines and H. simbellata. The example, or Side A file major species is the introduced C. floridatant at E. crimington, and the major H. critica at H. ambellata. Take richness and the Shanon-Weiner Diversity Index are higher for H. ambellata in June (Side A), but higher for E. cramines in August (Sides B and C. Take C). This crambales with the peak bleen of H. authelian in June, and the peak bleen of E. crambales in August.

(2) Beolikic Invertebrates: Oligochaptes represent the most abundant taxa overall/Fig.6: In June (Site A), taxa (contributed by the Contributed by

imposes that the first is the Vegetation Carepy. Chimoeridise and Collembols represent the misst abundant (A) Terrestrial length in the Vegetation Carepy. Chimoeridise in H. meterlate passess in the major difference with E. meterlate, Measurements of take the size and the Shannon-Wolner Diversity Index are similar for EAV last are both higher than emergent and dipartian state (United II).

(A) Fight Numbers and avange largiths for all lists explained in five series belianging insternesh five septimiter patches of P. Pressiper at site C, are as follows: 6 juvesile Blaegil! (Legends intercodurat), 75.85 mm; 34 small juvesile Blaegil! (Legends intercodurat), 75.85 mm; 34 small juvesile Blaegil! (Legends intercodurat), 75.85 mm; 34 small juvesile Blaegil! (Legends intercodurat), 75.85 mm; 38 small juvesile Blaegil! (Legends intercodurat), 75.85 mm; 38 small juvesile Blaegil! (Legends intercodurat), 75.85 mm; 58 small product intercodurate intercodurate intercodurate intercodurate. Note that intercodurate intercodurate, 75.85 mm; 58 small product intercodurate, 75.85 mm; 58 small product intercodurate. A FSS value of 64.36 with prey invertebrates in the true mass status for these fish and feeding mainly on the stailphipods, isopods, avycoplars symphs, and chievesouthing having in the oberitying most mass. The transition of the grey is plantation deep at all other sites. However, sampling by DWR in shiften water areas adjacent to the FAV patches has produced additional fish date. Diet staatyses on these samples illustrates Virillar trends in prey Sangity.

<u>Physical Sambles</u> At the B disorded express leads are eligible only lower undersont both FAY parches than at energies street, with E crimeters having a slightly lower value than H underlien (Fig. 9). At six Y, E, crimeters has a lower value than energies street, but H, underlien has a much higher value. This could be the lower has a lower value than energiest street, but H, undefined has a much higher value. This could be the lower has been value for an energy was suit at the couple of the many many patches in the couple of the many many many many many many and the but have a streety defined boundary.

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MEMORITY DESIGNATION

# CHHORNIA CRASSIPES (WATER HYACINTH) ON RAMENTO/SAN JOAQUIN DELTA, CALIFORNIA

ystem Team. University of Washington, Scattle, WA 08105.



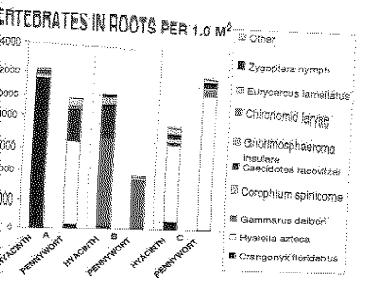
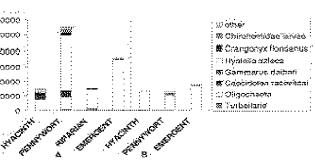


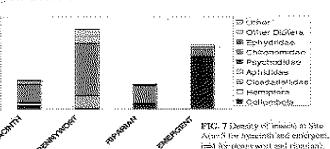
FIG. \$ Decisity of recoller entered on Sites A. B. and C (n=5).

### BENTHIC INVERTESPATES PER 1.0 m2



FRU 6 Density of beining investebrares at Sites A and B (8=5)

### SITE A: DENSITY OF INSECTS PER 1.0 M2



SITÉ C: E. crassipes BLUEGILL IRI



Fig. \$ 181 of Bloogist lish proy. Yotkow triangles represent 8 the genery of section see.

	<del></del>	· Persona
		ŢŸĦANNONL
į	İ	WEINES
	TRAA	DIVERSITY
i :	RICHNESS	i Sangv
ROOT INVER	TESPATES	
myacinth A	26	1.04
Pennyyon A	20	2.34
myacinth B	20	···
Parinywork B	- <u>\</u>	
Hyadmin o	27	<u>1.18</u>
Реплумон С		2.00
T-MONAGE C	20	1.02
<u> </u>		. 7
INSECTS		
<u>lifyedinth A</u>	24	2.2a
Pensywort A	. 25	
Emargent A	18	212 1.74
Ribarian A	18	1.7
	i	
SENTHIC INVE	RTEBRATE	S
Hyacinth A	16	2.51
Pennywort A :	13 7	7.92
Sinement A	7	0.25
Piparan A	3 ·	୍. ଅଞ୍ଚ
Нуваар Б	5 :	0.26
Респумов 8 :	12 :	1.47
Emergent B	4	Ç.31
TARIST 3 3.5 sac	laboration sufficiency	emo

TABLE ! Measurements of laxocicliness and the Spanisco Wester Diversity lades for representative investables sometime.



FEG. 2 Rydinsmyle limbellatd. Pennymen.
AVERAGE DISSOLVED OXYGEN LEVELS

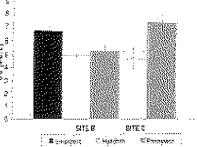


FIG. 9 Average descrived extegen lovels (right) in Sues (treid C) for emergent strutt (res)) and FWV strate (n=5)



807X A. Sumpled his phippeds (A+O) and isopests (F-F). A. Collegence Béridentes, Brat tilécété in the Pales, intecdence? R. Commune dealers', introduced. C. Produkt appear intition. D. Corculation spinicariae, mative. E. Constituentation maties in the pales in the Delta, histodenced? And Corculation on A, find relocal in the Delta, histodence? And Corculation on A, find relocal in the Delta, characteristic of Corculation dispendingly from Ania, introduced?

### CONCLUSION:

It is appeared that E. crossifies has had a remarkable importion paradiole habitats in the Sectemento-San found in Patia, or well arigh my other areas throughout the world. The invertebrate communities associated with C. crossifies already other analyse from the native H. analyticals. The invertebrate is the property of the property

### REFERENCES:

Cohen, A.W., and Carittini, J. T. 1998. Accelerating laveston rely in a highly invaded symbol. Science 1779-555, 558

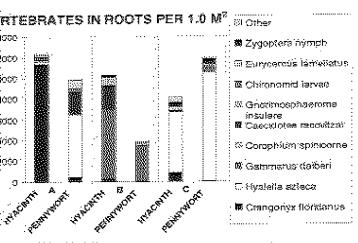
Gopal, B. 1987, Apparia Plant Scoties I. Water Hyadistic Libevier publishing, 371 pp. Nichols, F. H., Cloero, J. E., Janona, S. Ni, and Peterson, D. H. 1986. The maxification of an estuary. Science 231: 567-575.

Budhen, P. Peiserial Communication, Water Hyacinni Control, 193W.,

### HHORNIA CRASSIPES (WATER HYACINTH) ON RAMENTO/SAN JOAQUIN DELTA, CALIFORNIA



stem Team, University of Washington, Seattle, WA 98195.



P(C) 5 Density of root investobrates at Sites A, B, and C (not):

### BENTHIC INVERTEBRATES PER 1.0 m2

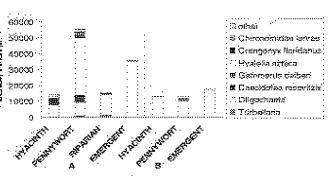
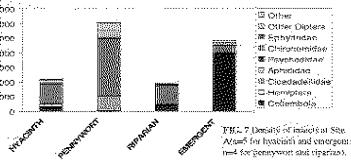
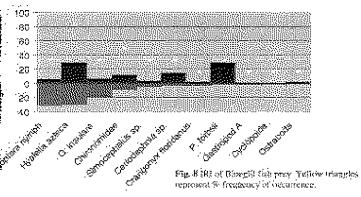


FIG. 6 Dunskly of English injurculations at Sites A and B (sub).

### SITE A: DENSITY OF INSECTS PER 1,0 M2



SITE C: E. crassipes BLUEGILL IRI

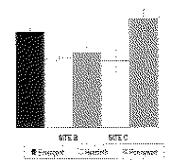


		филипов-				
		WEST				
	7AXA	DIVERSITY				
	FROM NORS	/NSEX				
ROOT INVERTEBRATES						
Hysonto A	26	1,64				
Pansyvast A	- 28	2,34				
iHvacksth B	25	1.68				
Pennywort S	16	1.18				
Hyacinth ()	21	2,99				
Pendywala C	20	1.02				
INSECTS						
Hyacinth A j.	. 24	2.25				
Pennywod A	25	2.12				
Smergest A	19	1.14				
Ripadan A	18	1.7				
BENTHSC INVESTEBRATES						
Hyscoth A	18	2,61				
Persywort A	13	1.92				
Spergent A	7	0.25				
Riparian A	ह	0.88				
Hyacieta 6	5	0.26				
Pencywort 3	17	1.47				
Emergent B		0.51				

TABLE 1 Measurements of time richness and the Stamont-Weiser-Diversity Index for representative invertebrate sampling.



EKC. Z Madrarntyké mnirékata, Podbymod. AVERÁGE DISSOLVĚD DXYGÉN LEVELS



#IG.9 Average dissolved expect teriol (right) as Sites Bland C for emergent string (ref) and FAV string (ref).



BOX As Samplois emphiguise (A.D) with inspecte (B.3); A. Companys Paiddonae first record in the Deta, introducest! B. Giomecnes deshort, introduced. C. Hostella discret, eative. Econophium spinicome, fative. B. Continuesphalenome intellere, pative. P. Caeridotea exercitaes, first record in the Deta, instealment? And Caeridotea sp. A. Sest mound in the Deta, connected size of Caeridotea hispandoigh some Asia, introduced?

### CONCLUSION:

is is apparent that \$\tilde{E}\$ crossipes has had a remarkable impact on monatoric hiddeling to the Sacramento/San Joaquin Delta, as well as many other areas throughout the world. The invertibinate communities associated with \$E\$ crossipes are often unique from the native \$E\$, underland. The invertibinate limits limits in the root tense some as previous for suident con-native \$E\$, underland. The invertibinates consist mealty of amphipids had isolated, many of which are introduced. It is open to speculative whether some of these crossaceans many have arrived into the \$E\$ or one in one mode of \$E\$ crossipes. All \$E\$ associated undermatic canopies of \$E\$, crossipes were juveliles, so it appries that the behave \$E\$ crossipes as both a solage habital and food resource, \$E\$, crossipes can have a detrimental effect on the analyting benchie compatify as compared to \$E\$ underland, the to high plant destrins deposition rate and look disordine compatify as compared to \$E\$ underland, the indigence of the controlling the special of \$E\$, crossipes, such preliminary findings waisnot more research on the role of \$E\$, crossipes, is the constants continuous.

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Cohen, A.N., and Christon, J. T. 1988, Accolarating breaster rate in whighly invoked contary Science (1985) SSS.

Gopal, B. 1987, Agentic Pinat Steffies 1, Weser Mysciath, Elsevier publishing; 471 pp. Nichols, F. H., Cloern, J. E., Luoma, S. N., and Peterson, D. H. 1986, The modification of advantage, Science 231; 567-573

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